ABDUCTIVE REASONING AND LIMITATIONS OF THE KNOWER

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ABDUCTIVE REASONING AND LIMITATIONS OF THE KNOWER

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LIST OF ABBREVIATIONS

AR	Abductive reasoning
BIAC	Belief into Action Scale
CRT	Cognitive Reflection Task
EBI	Epistemic Belief Inventory
EB	Epistemic belief
ETM	Evaluativist Thinking Measure
MD	Medical Diagnosis
NFC	Need for Closure
PTB	Pick the Best
R Span	Reading Span
RWA	Right Wing Authoritarianism

SUMMARY

Previous research has shown that a person's epistemic beliefs, cognitive style, and religiosity affect the level at which they are able to reason about a variety of topics. These studies have primarily focused on ill-structured, existential, and moral problems. This study examined the effects of epistemic beliefs, foreclosed cognitive styles, and religiosity on a newly designed measure of abductive reasoning (Hertzog, Hale, & Krepps, 2015). Abductive reasoning is reasoning to the best explanation based on given evidence. This evidence can be incomplete and the best explanation does not need to be the correct explanation. This is similar to scientific thinking because it involves generating and gathering support for or against a given hypothesis. This study also used a religious salience manipulation to prime participants. Previous work has shown that a religious salience manipulation alters behavior and has caused participants to perform more poorly on a scientific reasoning task (Rios et al., 2015), and reason less complexly about religious topics (Pancer et al., 1995). Undergraduate college students with different religious backgrounds completed computerized measures of abductive reasoning, epistemic beliefs, cognitive style, and cognitive ability. The religious salience prime did not shift participants' epistemic beliefs or reasoning style and there was no evidence of these variables affecting abductive reasoning. However, there were interesting relationships among the variables. Epistemic beliefs were related to cognitive style and religiosity. Religiosity was related to cognitive style. Right wing authoritarianism predicted epistemic beliefs in certain knowledge and omniscient authority. Epistemic beliefs, religiosity and cognitive reflection did not influence two critical aspects of abductive reasoning: the total number of candidate explanations generated, and the rated quality of reasoning. Need for closure, however did predict AR quality scores. Results suggest that aspects of beliefs that can

influence reasoning quality have little impact on advanced critical thinking about scientific scenarios.

INTRODUCTION

1.1 Abductive Reasoning

Abductive reasoning involves generating, evaluating, and refuting rival explanations for empirical findings (Hertzog, Hale, & Krepps, 2015). It requires formulating a hypothesis based on evidence and then using new information to adjust or reject the initial hypothesis (Hertzog, Hale, & Krepps, 2015; Lombrozo, 2012). Abduction is related to scientific thinking because it means reasoning to the best answer based on evidence. It involves formulating hypotheses and considering what conclusions could be drawn after testing these hypotheses. Kuhn (1989) refers to scientific thinking as involving: a. consciously articulating a theory that he or she accepts, b. knowing the evidence that could and does support the theory and evidence that could and does disconfirm the theory and c. justifying why the coordination of available theories and evidence has led to the acceptance of the preferred theory and the rejection of others (Kuhn, 1989). Similarly, critical thinking entails judging information, evaluating alternative evidence and arguing with strong reasons (Halpern, 1998). It requires that a person look beyond his or her biases and use evidence and reason (Halpern, 2014) Abduction involves both induction and deduction in that a person must look at a state of affairs and reason about possible explanations (deduction) and look at a variety of sources of evidence that lead to a specific conclusion (induction). Where abduction differs though, is that it allows a person to draw conclusions when the evidence does not lead to a complete interpretation (Moore, 2005; Moore & Malinkowski, 2009). Many unobservable causes may yield a given outcome and make it impossible to determine the exact cause, but through abductive reasoning, it is possible to come up with a highly likely explanation.

The first part of abduction and scientific reasoning requires formulating a hypothesis or an explanation about the state of affairs. Lombrozo (2006) notes that there is an "undisputed danger" in explanations because they embody prior belief; true beliefs can provide important constraints in reasoning whereas reasoning from false beliefs can preserve inaccuracy. Abduction does not concern reasoning about only one explanation, though. Instead, abductive reasoning requires a person to evaluate alternative proposed theories based on quality of evidence that supports or refutes them. Simplicity, breadth, consistency with prior knowledge, and coherence of an explanation improve perceived quality (Lombrozo, 2012). There seems to be a preference for simpler explanations, likely because these explanations avoid overfitting a situation and will better generalize to novel cases (Lombrozo, 2012).

When new evidence is encountered, explanations must be altered and refined to incorporate this new evidence (if it suggests candidate explanations should be modified). Alternatively, a person must have a compelling reason to discount this evidence that seems inconsistent with a candidate explanation, or formulate a new explanation that can account for the evidence. People who prefer a simpler explanation are likely to modify their hypothesis fewer times (Lombrozo, 2012), even in the face of weakly consistent evidence. This behavior is acceptable if the initial hypothesis can still account for the situation, however it can be maladaptive if the explanation is incomplete and requires modification. Therefore, it is important that a person remain open to new information and avoid committing too strongly to a hypothesis that may be disproven with more evidence, but not so open as to never come to a conclusion. It is also important that a person uses new evidence correctly and recognizes, as Kuhn (1989) mentions, what does and does not confirm or disconfirm a theory. This evaluative process allows a person to reason to the best interpretation of a situation, given the available information.

It is likely that the properties of explanations come as a side effect of cognitive characteristics rather than because they afford a specific advantage over other properties (Lombrozo, 2012). Lombrozo (2012) acknowledges that explanatory preferences, in both the formulation and evaluation of hypotheses could result from cognitive limitation as simpler explanations are easier to process and remember. Rather than define these limitations as deficits in cognitive ability, the current project aims to examine "limitations" as individual differences in personal epistemology, religiosity, and cognitive style. Whether these factors impact one's ability to reason abductively is a primary question for this research.

1.2 Personal Epistemology

Perry's (1970) seminal work found that first-year college students were likely to have a dualistic view of knowledge, wherein knowledge is either right or wrong, which then advanced as the student moved through secondary education into a more relativist way of thinking. In their early college days, students showed a preference for knowledge through authority that is certain and simple, often expressing discontent when professors tried to give them assignments that asked them to come to a conclusion themselves (Perry, 1970). Those with a dualist perspective use fact- oriented standards to assess comprehension while those who are more relativist use context-oriented standards (Ryan, 1984). These studies of lay epistemology continued, notably with Belenky, Clinchy, Goldberger, and Tarule (1986) exploring women from diverse educational settings and how their epistemological assumptions develop and differ from those of men. This perspective involves a connection between beliefs about the self, beliefs about authority, and beliefs about knowledge and

suggests that personal epistemology goes beyond certainty and source of knowledge (Schommer, 1994).

King and Kitchener's reflective judgment model examines personal epistemology and critical thinking. In their exploration of ill-structured problems, King and Kitchener found that a person's ability to reason through these problems develops with time and education. Ill- structured problems are defined as problems that cannot be solved using an algorithm because there is no single specific solution or answer and instead, require making judgments based on available evidence (King & Kitchener, 2002). Solving ill-structured problems involves a judgment process in which the person must decide if there is strong evidence toward any conclusion and if that conclusion closes the problem, at least temporarily, in a satisfactory way. Although everyone implicitly has a sense of the limits, certainty, and criteria of knowing, to succeed at solving ill- structured problems, a person needs to have beliefs that allow them to come to a relatively certain conclusion that is most appropriate based on the evaluation of available information and be willing to re-evaluate their judgments with new information that comes to bear (King & Kitchener, 2002).

It has been found that epistemic beliefs, a person's beliefs about what knowledge is and how it is acquired (Schommer, 1990), predict aspects of learning such as comprehending sciences and complex texts, and using integrative study strategies (Schommer, 1990; Schommer, Calvert, Gariglietti, & Bajaj, 1997; Schommer, Crouse, & Rhodes, 1992). Students who endorsed quick learning generally showed a lower high school GPA which may be because they did not use integrative study strategies (Schommer, 1993). Many beliefs about the structure, certainty, and source of knowledge, as well as the control and speed of knowledge exist. However, five epistemic beliefs: simple knowledge, certain knowledge, omniscient authority, quick knowledge, and innate ability have been identified and tested

(Benedixen, Schraw, & Dunkle, 1999; Kardash & Scholes, 1996; Schommer, 1990). Simple knowledge refers to the degree that knowledge is seen as isolated facts or as integrated concepts (Schommer, 1990). A belief in certain knowledge means that there is absolute knowledge and it will eventually be known (Schommer, 1990). Omniscient authority measures the degree to which people believe that authorities have access to knowledge that is inaccessible to others (Schommer, 1990). Quick learning means that learning occurs quickly or not at all. Finally, the belief in innate ability concerns the idea that the ability to acquire knowledge is endowed at birth (Schommer, 1990).

By conceiving epistemic beliefs as a system of independent beliefs, it is possible to assess how single beliefs as well as combinations of beliefs contribute to various outcomes (Schommer, 1994). This conception also acknowledges that people can be mature in some aspects of epistemology and immature in others (Schommer, 1994). These separable beliefs can fit into a larger developmental model as asynchronous patterns of belief may reflect a transition between the stages (Schommer-Aikins, 2004). The abductive reasoning scenarios present ill- structured problems, thus it is expected that participants' beliefs about knowledge, specifically belief in simple knowledge, certain knowledge, and omniscient authority, will influence their abilities to succeed in this task.

Epistemic beliefs are based largely on culture and how a person is taught. For instance, compared to American students, Chinese (Qian & Pan, 2002) and Omani (Karabenick & Moosa, 2005) students are more likely to believe that knowledge is simple and certain. Schommer- Aikins' (2004) embedded systemic model of epistemic beliefs posits that a person's cultural views are involved in learning to the extent that they reinforce a hierarchy between lay people and experts, that is, the person is not at the same knowledge level as the expert and the expert has supreme status due to his or her knowledge. Someone raised in a

society with hierarchical authority is more likely to accept omniscient authority claims (Schommer- Aikins, 2004). In a predominantly Muslim, authoritarian society, Omani students, especially Omani men, who participate more in political and religious affairs, were found to be more likely to accept knowledge from authority than US students (Karabenick & Moosa, 2005).

1.3 Religiosity

Religious teachings seek to imbue beliefs about the origins of God and man but also a sense of what truth is and how it can be attained. As a meaning system, religion offers certainty, truth, and information about how the world works. It consists of cognitive, emotional, and motivational components that shape a person's sense of meaning (Razmyar & Reeve, 2007). Religious beliefs, then, provide a lens through which one can observe, understand, interpret, and evaluate the world and direct behavior (Razmyar & Reeve, 2007). For example, in a study of Omani students, Karabenick and Moosa (2004) hypothesize that the authority rich environment of mosques may create habits of reliance on others, which then generalizes to Omani's epistemic assumptions about science.

Religious quest is "the degree to which an individual's religion involves an open-ended, responsive dialogue with existential questions raised by the contradictions and tragedies in life" (Batson, Schoenrade & Ventis, 1993, p. 169). The quest orientation toward religion allows for questioning and doubting, and takes an open and flexible stance on religious issues (Batson et al., 1993). Religious quest is related to greater cognitive complexity regarding religious questions (Batson & Raynor- Prince, 1983). Fundamentalist religion, on the other hand, emphasizes the truth in their scriptures as it is written (Altemeyer & Hunsberger, 1992). There is no room for interpretation or integration because their teachings clearly contain the "basic, intrinsic, essential, inerrant truth" (Altemeyer &

Hunsberger, 2004, p. 118). Quest and fundamentalism may represent a unique style of epistemic cognition, with specific beliefs about the simplicity, certainty, authority, and speed of knowledge because they deal with assumptions about knowledge and truth (Hunsberger & Jackson, 2005).

Right wing authoritarianism (RWA) stresses submission to the laws of a supreme authority such as a religious or political leader (Altemeyer & Hunsberger, 2005). Cook (2011) notes that religious fundamentalism reinforces and at times directly teaches the core values of RWA including trust in law enforcement, upholding social conventions, and valuing punishment for those who violate social norms. Fundamentalism measures RWA specifically for religious beliefs and, according to Altemeyer (1996), may be viewed as a religious manifestation of RWA (Altemeyer & Hunsberger, 2005). Right-wing authoritarianism is related to an absolute approach to knowledge, a lack of imagination, and an inability to see problems from alternative perspectives (Laythe, Finkel & Kirkpatrick, 2001). Fundamentalism and RWA have both been associated with belief in certain knowledge, simple knowledge, and omniscient authority (Hathcoat & Barnes, 2010).

One possibility is that the ability to engage in abductive reasoning will be less influenced by what the belief is and more influenced by the type of belief. A committed atheist, for example, may show similar performance to a fundamentalist because of their commitment to certain knowledge; yet both have little doubt about what the truth is even though their truths are very different. This dogmatic approach will likely impede consideration of different perspectives. Additionally, the degree of commitment to a religious doctrine is predictive of reasoning. Students who expressed more religious doubt tended to think in more integratively complex ways about those doubts and existential material in general (Hunsberger, Alisat, Pancer, & Pratt, 1996). Religious doubt may indicate less belief

in the certainty of religious knowledge as well as less belief in authority as a source of knowledge (Hathcoat & Barnes, 2010). Fundamentalism is associated with belief in creation science, dogmatism in the face of opposing scientific evidence, an aversion to doubt, a need for closure, and extreme attitudes about personal beliefs (Altemeyer & Hunsberger, 2005; Brandt & Reyna, 2010). People who were fundamental in their beliefs tended to take new information and meld it with their religious beliefs whereas low fundamentalists were more likely to adapt their religious beliefs (Hunsberger, Alisat, Pancer, & Pratt, 1996). However, both religious and non-religious people have shown similar levels of integrative complexity when asked to reason about secular issues (Pancer et al., 1995) and religious people were more likely to respond to prompts for integrative complexity than non- religious people (Hunsberger et al., 1994). For those low in fundamentalism, the significant correlation between complexity scores for religious and nonreligious topics suggests that integrative complexity could be thought of as a trait (Pancer et al., 1995). In the case of fundamentalists, the absence of correlation between secular and religious complexity could mean that only a small number of topics, especially those that are relevant to a persons' identity, actually elicit more simplistic thinking and thinking about other topics could depend on individual differences in a complex thinking trait (Pancer et al., 1995).

1.4 Cognitive Style

Similar integrative complexity for secular issues in fundamentalist and non-fundamentalist individuals implies that there may not be differences in cognitive ability between these two groups. Whereas cognitive ability is a capacity for analytic reasoning, cognitive style implies motivation or a disposition to engage in the reasoning process (Pennycook, 2014). Individual differences in cognitive style have been shown to predict reasoning performance over cognitive ability (Stanovich & West, 2000). One such style is the

need for closure, or the desire for a firm answer to a question and an aversion toward ambiguity (Kruglanski & Webster, 1996). Need for closure is both a trait and a state that can be elicited by different task demands (Kruglanski & Webster, 1996). This need creates a desire to search for information to reach a conclusion in an ambiguous situation.

Need for closure can be affected by epistemic beliefs because a degree of certainty is involved in "closing" a problem. Belief in the simplicity of knowledge could also cause a person to value early closure over leaving a problem open and ready for integration. Belief in omniscient authority should increase a need to close on information from that authority because this could be seen as the most valid source of information. Any desire to not close for fear of being wrong would be overridden, which therefore reduces critical thinking (Kruglanski & Webster, 1996). Need for closure can be seen in the abductive reasoning task in that people with a high need to close on a solution may generate fewer answers, show higher confidence in these answers and be less likely to incorporate new evidence when reasoning toward the best answer because this may influence the permanence of a decided upon solution. Need for closure could be implicated in religiosity. Oftentimes, those from a fundamentalist orientation surround themselves with likeminded individuals to avoid being challenged; this demonstrates a preference for permanence in knowledge.

Another cognitive style now widely assessed is cognitive reflection, the ability to suppress an intuitive and spontaneous, incorrect, answer in favor of a reflective and deliberative correct answer. This concept is based on the idea of dual process theory in which there is type I thinking that offers fast and heuristic responses and then a type II thinking that is deliberative (Stanovich, 2011). These two types of processing are thought to be done in the autonomous system (type 1) and the analytic system (type 2). The initial override of the intuitive answer is achieved by what Stanovich calls the "algorithmic mind," part of the

analytic system, although the individual differences in thinking dispositions are thought to lie in the "reflective mind" (Stanovich, 2011). When a person's beliefs and personal theories are not treated as cognitive entities and not subject to critical introspection, a heuristic strategy often prevails (Klaczynski, 2000; Kuhn, Amsel, & O'Loughlin, 1988; Stanovich, 1999).

One theory of ideological differences, that is differences in systems of beliefs or theories, is that they are associated with the extent to which a person relies on intuition or reflection in decision making. There is a great deal of support for the idea that differences in intuition and reflection explain differences in individual religiosity (Pennycook et al., 2012, 2014.) A newer line of work implicates religious disbelief as a result of type II thinking. Over a series of experiments, Gervais and Norenzayan (2012) found that those with initial analytical tendencies were more likely to show religious disbelief. Manipulations to trigger analytic processing also resulted in increased religious disbelief (Gervais & Norenzayan, 2012). The authors take this as evidence that thinking analytically is one method of promoting religious disbelief (Gervais & Norenzayan, 2012). An analytic cognitive style negatively predicts religious beliefs (heaven, hell, angels and demons, miracles etc.) and paranormal beliefs (ESP, ghosts, etc.) controlling for cognitive ability, religious engagement, sex, age, political ideology, and education (Pennycook et al., 2012). The authors attest that more analytic thinkers are likely to dissect supernatural belief and detect violations of the naturalistic worldview than are those who think less analytically (Pennycook et al., 2012). Analytic cognitive style also predicts nuanced God beliefs with higher performance on analytic measures being more likely to adopt more abstract God beliefs that serve to resolve conflicts between faith and naturalism (Pennycook et al., 2012).

1.5 Epistemic Assumptions and Critical Thinking

Broadly, epistemic assumptions may predict whether a person will engage in critical thinking or not. If knowledge is regarded as completely objective and certain, or conversely, if knowledge is taken to be completely subjective, critical thinking is unnecessary. Kuhn and Weinstock (2002) identify four levels of epistemological understanding to illustrate the progression from objective to subjective dimensions of knowing. The highest level is the coordination of objective and subjective understanding. These levels appear to be directly relevant to the likelihood that people will engage in extensive consideration of alternative explanations for events and event outcomes.

At the first level, the "realist" level, reality is directly knowable and certain because all assertions are copies of external reality. There is no need to critically think because everything is known with certainty. Those at the second "absolutist" level see knowledge as directly apprehended or based on the authority of experts (Kuhn & Weinstock, 2002). All new propositions of knowledge are met by a comparison with the "known" truth (Kuhn & Weinstock, 2002). This is an example of basic critical thinking, as a person must compare ideas to see if new ideas line up with the truth. Along with strong beliefs in authority as a source of knowledge, absolutists see knowledge as simple and certain.

At the third "multiplist" level, people do not subscribe to the idea of epistemic certainty (Kuhn & Weinstock, 2002). For them, knowledge is created by the human mind (Kuhn & Weinstock, 2002). The views of experts or authority are seen as no better than those of others and there is no way to determine an overall strength of argument. For people with this perspective, critical thinking is a moot point, for there is nothing to criticize.

Lastly, someone at the final "evaluativist" level recognizes that not all opinions are equal and that knowledge is gained through making judgments, evaluation, and argument (Kuhn & Weinstock, 2002). At the same time, these people recognize that there may be no absolutely correct choice among rival explanations. People with this perspective are more willing and able to engage in critical thinking because they see its value and necessity in gaining knowledge. These people see knowledge as uncertain, integrated, and complex.

These levels are evaluated by presenting two contrasting claims and asking if one could be right or if both could be right (Kuhn & Weinstock, 2002). This shows if the person is absolutist or multiplist in his or her thinking. The second task involves determining which claim has more value (Kuhn & Weinstock, 2002). This reveals if the person can think evaluatively (the highest level). This task is similar to the abductive reasoning task, which asks participants to generate explanations that have the potential to be right and then evaluate these explanations to find the best one. Success on the abductive reasoning task then depends on the level of epistemological understanding.

In the case of drawing inference, theoretical belief drives inference rules and strategies that can lead to different strategies applied to the same types of evidence (Kuhn & Dean, 2004). In a scientific reasoning paradigm, Kuhn and Dean (2004) saw that participants "protected" their unsupported theories by particularizing the inference, which implies that though the theory does not hold for this exact situation, it does hold otherwise. They observed that most adults were able to use valid rules of causal and non-causal inference but also fell victim to erroneous inferences when they applied the wrong strategies (Kuhn & Dean, 2004). The major difference was not in their ability to use strategies but how frequently they applied different strategies (Kuhn & Dean, 2004).

Though Kuhn and Weinstock (2002) take the perspective that epistemological thinking is developmental in nature, they concede that significant variability exists in adolescents and adults and that even well into adulthood, most do not reach the evaluativist level. A person's beliefs do not develop synchronously and vary by knowledge domain (Karabenick & Moosa, 2005). They may even depend on the specificity of the reference domain be it knowledge in general, a scientific domain, or a specific area of research (Karabenick & Moosa, 2005). Therefore, it is useful to explore personal epistemology as separate beliefs.

1.6 Influence of Epistemic Beliefs, Cognitive Style and Religiosity on Abductive Reasoning

The abductive reasoning task developed by Hertzog, Hale, and Krepps (2015) presents a person with a vignette that poses a phenomenon that needs to be explained and then provides limited evidence that can inspire alternative explanations. Participants are presented with the scenario and evidence and asked for candidate explanations. With each explanation, they are asked to describe and justify why this is a potential argument. They then compare and rate their explanations. After this comparison, they receive new evidence that is somewhat ambiguous but designed to shift the participant toward some candidate explanations and away from others. They are asked to integrate this new evidence into their existing explanations by determining if this changes their rating of explanations and if they generated any new explanations. Finally, they are instructed to choose their best explanation and defend it using the presented evidence and compare it to their other proposed explanations.

I hypothesized that epistemic beliefs, cognitive style, and religiosity will influence abductive reasoning by determining whether a person will engage in abductive reasoning and, beyond engagement, if they will be effective at it.

Developing a strategy to pick an explanation or adapt new knowledge into an existing explanation involves understanding knowledge. Basic differences in assumptions about what can be known and how knowing occurs differentiate those who use reflective judgment and those who do not critically evaluate their opinions (King & Kitchener, 2002). Differences in epistemic beliefs have been shown to impact moral reasoning (Benedixen, Schraw, & Dunkle, 1998), and predict aspects of learning. Epistemic beliefs may be linked to reasoning biases because individuals assign different values to theory preservation or knowledge acquisition (Klaczynski, 2000).

Belief in certain knowledge impacts how people interpret information, the more a person believes in certain knowledge, the more likely that person is to interpret tentative information as absolute and certain while those who believe that knowledge is more uncertain are more tentative in their conclusions (Kardash & Scholes, 1996; Schommer, 1990). Moreover, closed-minded individuals are more likely to treat their beliefs as fact (Kuhn et al., 1988). This implies that people use a top-down process to compare new knowledge to their prior knowledge. Previous studies have examined how knowledge about a topic and certainty in that knowledge affects reasoning about that topic and have found assimilation effects (Kardash & Scholes, 1996). Those who believe in quick knowledge showed less understanding of a passage and drew unfounded conclusions but were still confident in their comprehension (Schommer, 1990). Believing knowledge is integrated is related to understanding scientific concepts (Schommer, 1990). Belief in simple knowledge, or knowledge as isolated facts rather than interrelated facts, can impact a person's ability to

use new evidence as these people will see new evidence as isolated facts and not see what it means in relation to their proposed explanations.

Epistemic beliefs determine how a person confronts ill-structured problems. In these situations, there may be more than one way to solve a problem, more than one solution to a problem, and the "correct" solution may not be clearly defined (Kitchener & King, 1981). Basic differences in assumptions about what can be known and how knowing occurs differentiate those who are able to think through ill-structured problems from those who cannot (King & Kitchener, 1981). In a study with entering and graduating seminary students, Dale (2005) found no difference in students' reflective judgment scores which suggests that seminary does not increase reflective judgment skills. Students also used the same epistemic assumptions to solve both secular and religious ill-structured problems (Dale, 2005). Less is known about how beliefs about knowledge in general will influence abductive reasoning.

In a study that involved solving geometry problems, Schoenfeld (1983) found that students commonly believe that only gifted authority figures can truly understand mathematics (ability), that mathematical problem solving should occur quickly or not at all (quick knowledge) and that mathematics are handed down by authority figures. According to those in Schoenfeld's study, people become authority figures because they are gifted experts with the capability to learn quickly (Schommer- Aikins, 2004). Beliefs regarding the control and speed of learning affect the degree of persistence when engaged in a difficult task (Schommer, 1994; Dweck & Leggett, 1988). Students who believe in a fixed ability to learn are also less likely to value education (Schommer & Walker, 1997).

A perspective grounded in individual differences in cognitive style also predicts that need for closure should also affect abductive reasoning. Under an increased need for closure, internal hypothesis generation is reduced (Mayseless & Kruglanski, 1987). Confidence in

proposed hypotheses, however, increases under need for closure conditions (Mayseless & Kruglanski, 1987; Kruglanski & Webster, 1991; Kruglanski, Webster & Klem, 1993; Webster, 1993). Increased confidence in hypotheses has also been shown in people with a natural need for closure (Webster & Kruglanski, 1994). Participants in a high need for closure condition may refrain from generating specific alternatives to a proposed hypothesis and look more for prototypical information, while those with a need to avoid closure are more likely to examine evidence that provides diagnosticity between conditions (Kruglanski & Mayseless, 1988). Those high on need for closure are also more likely to base final judgments on early clues (Kruglanski & Webster, 1996). In abductive reasoning then, it is expected that those with a high need for closure propose fewer explanations, show higher confidence in these explanations and are less likely to come up with a new explanation when given new evidence. The new evidence is used selectively to lend credit to the initially preferred theory.

In order to reason abductively, a person needs to get beyond type I heuristic thinking and move into the reflective mode. Theory-motivated reasoning occurs when individuals fail to reason independent from their theories (Klaczynski, 2000). There is some debate about whether a person must always override the default mode to access type II thinking (these processes occur sequentially) or if a person activates type I and type II thinking in parallel. Serial processing explains the relationship between the CRT and some outcomes, although other processes, like moral reasoning are likely related to parallel processing. That is, the way people differ in their initial approach to a CRT problem (intuitive or reflective) informs their performance on a moral reasoning task (Baron, Scott, Fincher, & Metz, 2015). Individuals who did not take an analytic approach to reasoning about information that was incongruent with a previously held theory were also more likely to reject this information as "implausible," a heuristic response (Klaczynski, 2000).

Biased reasoning can still take place in the analytic mode. If information does not match with a predefined theory, biased analytic processing may be used to adapt the information to fit with one's theory and create an unfounded belief that a person has reasoned to a stronger theory (Klaczynski, 2000). This belief polarization is most likely among those who are more biased to an initial theory (Klaczynski, 2000). In a study involving adolescents, Klaczynski (2000) found that epistemological dispositions were negatively associated with analytic reasoning biases. Klaczynski (2002) hypothesized that epistemic beliefs about the nature, certainty, and acquisition of knowledge may impact evidence evaluation more than personal theories like religion. For these "knowledge-driven" adolescents, individual differences related to intellectual self-regulation create a thinking style in which knowledge acquisition trumps theory preservation as the primary goal (Klaczynski, 2000). The results indicate that "knowledge-driven" adolescents were less likely to rely on biased analytic reasoning, less likely to polarize their theories, and more likely to have well-developed scientific reasoning competencies than "belief-driven" adolescents (Klaczynski, 2000). The extent of polarization in theories about religion was greater when participants' personal religious beliefs were presented in a negative light (Klaczynski, 2000). Those more inclined toward type II thinking, but also not so strongly committed to a theory are expected to engage in and perform better on critical thinking tasks, like the abductive reasoning task and express less religious belief. In a validation study of the AR task, Hertzog and colleagues (2015) found that cognitive reflection is positively correlated with abductive reasoning but the relationship is related to fluid intelligence which means that there was not a specific relationship between heuristic decisions and abductive reasoning quality. This study again tests the relationship between type I and abductive reasoning.

Though it has not been examined in previous validation studies of the abductive reasoning task, it is possible that the explanations offered in the AR task might be influenced

by religious doctrine. For example, falling ill after spring break may be God's punishment for a week filled with sin. Some responses seemed to hint that the students were deserving of illness if they engaged in certain type of amoral activities, but without knowledge of participants' religion, it is not possible to see if this relationship exists. In the wine scenario, it is possible that people who hold the belief that drinking alcohol is sinful will be unable to reason about potential health benefits of wine. Focusing on sacred teachings as the only source of explanation limits the cognitive complexity of thought (Hunsberger et al, 1994; 1996; Sherkat, 2006), so it is expected that most fundamentalists show poor reasoning quality. This is due to certain cognitive styles associated with religiosity as well as the epistemic assumptions tied to religious beliefs.

Finally, cognitive ability is shown to be inversely related to religious beliefs (Bertsch & Pesta, 2009; Razmeyar & Reeve, 2013). Nyborg (2009), and Dawkins (2006), among others propose that this is due to people of higher intelligence having the capacity for skeptical and scientific thinking that is inconsistent with faith. Also, reduced cognitive ability reduces the ability for critical thinking in all domains. People of higher intelligence are more likely to reject dogmatic meaning systems (Nyborg, 2009). People of lower intelligence are more likely to define the world as complex. Unable to explain their surroundings, they are likely to gravitate toward prescribed belief systems (Razmyar & Reeve, 2013). Cognitive ability is implicated in abductive reasoning; however, individual differences in epistemic beliefs, religiosity, and cognitive style are expected to account for more variation in abductive reasoning performance

1.7 Religious Salience Manipulation

To better assess the relationship between religion, epistemic beliefs, and reasoning, this study seeks to experimentally increase the salience of religious beliefs. Under a dual-

processing framework, one way to shift someone into an analytic mode is to make the information to be processed self-relevant (Petty et al., 1981). Although much of the work focuses on making information relevant to the self as an individual, some work has examined self-relevance to the extent that the self is seen as a member of a group. Identity salience can change how people process information, but results are mixed. One study found that social identity salience causes people to process group relevant information analytically (Maitner et al., 2009). Maitner and colleagues (2009) found that after a manipulation that emphasized their identity as a student, an American, or an individual, participants interpreted the same information at different levels (heuristically or analytically) depending on which identity was salient. Simply activating a person's social identity altered what information was used and how that information was used (Maitner et al., 2009). Petty, Cacioppo, and Goldman (1981) found that if a message was highly relevant, participants' attitudes depended on the quality of arguments in the message but if the message was not relevant, attitudes were influenced by the expertise of the source. Other work has shown, though, that in-group relevant arguments do not always translate to more reflective thinking. If an accepted member of the group's attitude is known before his/her arguments, that attitude is likely to be adopted as a group norm without further processing (Mackie et al., 1992). Information presented by other in-group members is seen as more persuasive than information presented by out-group members (David & Turner, 1996) and people are more likely to pay attention to in-group messages (Alvaro & Crano, 1996).

Religious salience priming is often used in studies of moral judgments. Those exposed to religious primes are shown to demonstrate more prosocial behavior (Shariff & Norenzayan, 2007) and decreased ratings of moral appropriateness for ambiguous situations (Blanchard- Field, Hertzog & Horhota, 2012). Outside the domain of morality, reminders of God increase risk taking (Kupor, Laurin & Levav, 2015) and influence verdicts by increasing

intolerance for ambiguity and certainty in judgments (Sagioglou & Forstmann, 2013). Laurin, Kay, and Fitzsimmons (2011) found that a God prime reduces active goal pursuit while increasing temptation resistance, religious salience thereby having a divergent effect on goal directed behavior. The presence of religious imagery influences political behavior with voters in churches who show more support for conservative candidates and constitutional amendments relevant to the Christian faith (Rutchick, 2010). These outcomes were demonstrated in both religious and non-religious participants, however, a meta-analysis by Shariff, Willard, Anderson & Norenzayan (2015) found that religious priming does not reliably affect non-religious participants. This suggests that religious primes activate an identity/ thinking style that is unique to religious people. This is due to differences in core epistemic assumptions.

Implicit identity priming can facilitate or inhibit performance (Shih, Pittinsky, & Ambady, 1991). Priming a Christian identity caused Christians to be less interested in and identify less with science as well as underperform on science relevant tasks (Rios, Cheng, Totton & Shariff, 2015). Both self-identified Christians and non- Christians were administered a scientific reasoning task that was identified either as scientific reasoning or as an intuitive thought task (Rios et al., 2015). Participants were told that the study was interested in performance differences between Christians and non- Christians (Rios et al., 2015). Christians performed more poorly than non-Christians when they were told that task measured scientific reasoning. Furthermore, reduced performance was seen on both easy and difficult items suggesting that Christian participants disengaged from the scientific reasoning task as a whole. This could be an effect of Christians rejecting fields that do not match their identity or seem incompatible with their values. In a context that values rationality and empiricism as a basis for truth claims, it is likely that religious beliefs are vulnerable if they are examined analytically (Pennycook et al., 2014).

Fundamentalism is a predictor of a strong tendency to identify with a religious group (Cook, 2011) and people high in fundamentalism were likely to have experienced a distinct emphasis on their religious group identity during childhood (Altemeyer, 2003). These people get a great deal of meaning out of their group affiliation. Therefore, it is expected that religious primes will be effective on fundamentalists, however they may not show demonstrable changes in their epistemic assumptions, cognitive reflection, need for closure, or RWA. It is assumed that these individuals are already acting on extreme beliefs and it is difficult, if not impossible to move them. The religious salience manipulation, then, is expected to work best on those who report moderate religiosity because they have the initial beliefs associated with religiosity but their beliefs are not so extreme that they cannot be altered.

The current study examines the relationship between epistemic assumptions, religiosity (measured by quest, religious action, and fundamentalism), and cognitive styles, like cognitive reflection, NFC, and RWA, and how these variables contribute to a foreclosed thinking style which then influences abductive reasoning. To further explore the effect of religion on epistemic beliefs, thinking style, and reasoning, a religious prime is used to try to shift people into a religious mode of thinking.

CHAPTER 2. METHODOLOGY

2.1 Participants

Two hundred forty- six participants were obtained through the Georgia Tech participant pool, which is composed of students enrolled in Georgia Tech psychology courses. The sample was 53.6% women, M age = 21.2 SD = 2.38, 44% identified as White. Although the majority of the sample identified with a religion of some type, 48% identified as not religious, which includes people who are atheist, agnostic, or spiritual. This is in line with what was expected based on data about student religious affiliation. See Table 1 for a breakdown of student demographic information.

Table 1

Demographics

	Percent of Sample
Gender (Female)	53.6
Race	
White	44.0
Black	9.7
Asian	34.7
Other	8.1
Political Affiliation	
Conservative	14.1
Liberal	44.0
Moderate	41.1
Religion	
Christian	26.6
Catholic	11.3
Hindu	10.5
Jewish	2.4
Buddhist	2.0
Muslim	1.2
No Religion	37.9
Unaffiliated-Other	7.3

2.2 Design

This study attempted to make feelings of religiosity more salient by using a religious priming task, and then assess the effects of this prime on epistemic beliefs, identity salience, thinking measures, and abductive reasoning. The majority of measures are quantitative, with qualitative coding involved in the AR task.

2.3 Procedure

The study consisted of two sessions, one one-hour session and a second two-hour session. In the first session participants entered the lab and filled out the informed consent form. All data were collected on the computer using Google Forms unless otherwise noted. All paper and pencil tasks were changed into Google Form format. Participants filled out a demographics questionnaire with their age, gender, academic information (year in school, major, minor), religious affiliation, parent religious affiliation, who they were voting for in the upcoming election (all data were collected before November 8, 2016), their political affiliation, and their parents' political affiliation. They then completed the evaluativist thinking measure, the letter sets task, the RWA, shortened reading span task, and the Shipley vocabulary. In the second session of the study, participants were randomly assigned to a religious prime or a control condition. Half of the participants were assigned to each condition. In both conditions, participants completed the religious prime, presented as a "Verbal Reasoning Task." The priming instrument is a sentence-unscrambling task where participants are given 5 words and they must drop the irrelevant word and then make a sentence with the 4 remaining words. There are ten sentences total. For participants in the religious salience condition, five of the sentences contain religious content and the other five

are neutral. In the control condition, all the sentences are neutral (See Appendix B for complete list of priming sentences; Shariff & Norenzayan, 2007). To provide a delay between the prime and the manipulation check, participants filled out a personality questionnaire. After a brief delay, participants indicated their top five most salient identities on a free response Google Form question to indicate if the prime had made religion a salient identity (Benjamin, Choi Fischer, 2010). The participants then completed the AR task. This task was done on the computer but not on Google forms. Half of the participants completed the Wine vignette while the other half completed the Medical Diagnosis (MD) vignette. This condition was counterbalanced with the religious salience prime so that there were four randomly assigned groups (religiously primed wine, religiously primed MD, neutral prime wine, neutral prime MD). Next, the participants did the CRT task on the computer using a Live Code program. This was labeled as a numerical cognition test. Participants then completed the shortened need for closure scale, followed by the belief into action questionnaire, the quest scale and the fundamentalism scale. After the completion of these tasks, participates started the debriefing phase where they answered questions about the study in which they had just participated including questions about which tasks were connected and what did they think was the point of the study to see if they were suspicious of the prime and to identify demand characteristics. They were then debriefed about the purpose of the study and participation was complete. All participants received one credit research credit for completing the first session and two research credit for the second session for a total of three credits.

2.4 **Measures**

The abductive reasoning (AR; Hertzog, Hale & Krepps, 2015) task consists of two scenarios that require the person to reason about an outcome and generate possible explanations for this outcome. New evidence is presented and participants are given the

opportunity to adjust their initial explanations or generate new evidence based on these explanations. The AR procedure is scored for number of explanations, quality of explanations, and new explanations after new evidence, evaluating and changing explanations considering new evidence, and choosing the best explanation and overall reasoning quality. See Appendix A for examples of the initial and additional evidence in the Wine and Medical Diagnosis scenarios.

The epistemic belief inventory (EBI; Schraw, Bendixen, & Dunkle, 2002) is a 32-question assessment for five factors of epistemic assumptions: certain knowledge, quick learning, simple knowledge, innate ability, and omniscient authority. Participants rate their degree of agreement with statements about learning and knowledge on a scale of 1 (strongly disagree) to 5 (strongly agree). This inventory has been chosen because of its improved factor loading on the omniscient authority dimension compared to the Schommer epistemological questionnaire, which did not get a factor loading on omniscient authority (Schraw, Benedixen, & Dunkle, 2002; Schommer, 1990).

The evaluativist thinking measure (Kuhn, Cheney, & Weinstock, 2000) has 15 items that present two contrasting claims and asks if one could be right or if both could be right. This shows if the person is absolutist or multiplist in his or her thinking. The second task involves determining which claim has more value. This reveals if the person can then think evaluatively about claims. Scores are calculated in five areas of judgment: personal taste, aesthetics, value, social world, and physical world. (Cronbach's αs are .31,.70, .09, .48, and .64, respectively. Each subscale is determined by 3 items.) See Table 2 for percentages of participants at each level.

Table 2

Evaluativist Thinking Measure- levels of evaluativist thinking for different types of judgments

	Absolutist (% of Sample)	Multiplist (% of Sample)	Evaluativist (% of Sample)
Personal Taste	2.4	70.2	26.2
Aesthetics	2.0	72.6	24.2
Value	31.9	39.1	27.8
Social World	6.0	25.8	67.3
Physical World	35.5	22.2	41.1

The Belief into Action Scale (BIAC; Koenig et al., 2015) is a 10-item scale designed to assess what a person values in life and the extent to which a person has consciously chosen to dedicate his/ her life to his/her religious beliefs. Participants indicate their highest priority and then on a scale of 1 to 10 rate their participation in religious activities such as attending services, religious gatherings, dedicating life to the service of God and donating money to religious institutions or causes (Cronbach's $\alpha = .89$).

The religious quest scale (Batson, Schoenrade, & Ventis, 1993) is a 12-item measure of a person's perception of religion as a quest. Respondents answer each item on a scale of 1 (strongly disagree) to 9 (strongly agree). Quest is measured by three factors: readiness to face existential questions ($\alpha = .75$), perception or religious doubt as positive ($\alpha = .63$), and openness to change ($\alpha = .77$).

The revised religious fundamentalism (Altemeyer & Hunsberger, 2004) scale is a 12-item measure to assess the belief that there is one set of religious teachings that contains the fundamental, basic, inerrant truth about humanity and deity. Participants answer each item on a scale of -4 (very strongly disagree) to 4 (very strongly agree) (α = .94).

The short version of the Revised -Need for Closure scale (NFCS; Roets & Van Hiel, 2011) is a 15-item scale that assesses individuals' motivation for information processing and judgment. The scale is based on the original Need for Closure scale (Kruglanski, Webster, & Klem, 1993). Closure is defined as a desire for an answer in order to end further information processing and judgment. Participants rate their degree of agreement with statements about predictability, structure, ambiguity, decisiveness, and closed-mindedness on a scale of 1 (strongly disagree) to 6 (strongly agree) (α=.83).

The expanded Cognitive Reflection task (Toplak, 2013) is a 7-item version of a measure designed to assess a person's ability to suppress and intuitive answer in order to give a reflective, correct answer (Frederick, 2005). It is presented as 7 math problems, the first 6 are free response and the last is a multiple-choice question. The measure is scored by the total number of correct items (α=.68).

The right wing authoritarian scale (Altemeyer, 2006) is a 22-item survey designed to examine a person's agreement with authoritarian values including willingness to submit to authorities, adherence to societal conventions and norms and are punitive to those who do not adhere to norms. Participants answer on a scale of -4 (very strongly disagree) to 4 (very strongly agree) (α =.91).

The shortened reading span task (Oswald, McAbee, Redick & Hambrick, 2014) presents a set of sentences (10-15 words long) and asks participants to judge if the sentence

makes sense. About half of the sentences make sense. A letter is presented after each sentence to recall at the end of the set. The sets range from 4 -6 sentences in length and each set length is administered twice. This task is done on the computer.

The Shipley Vocabulary test (Zachary, 1986) displays four words and asks participants to select the word that is most similar to the prompt word. This task has been computerized ($\alpha = .68$).

The letter sets test is a test of inductive reasoning. It consists of five sets of four letters. A person must find the rule that relates four of the sets to each other and mark the one that does not fit the rule. There are 30 letter sets and participants are given 14 minutes (Ekstrom., French, Harman, & Dermen, 1976) ($\alpha = .81$). See Table 3 for descriptive statistics of all variables.

Table 3

Means and Standard Deviations of Epistemic Beliefs, Cognitive Ability, Cognitive Style, Religion and Abductive Reasoning Measures

	Mean	SD	Range
Epistemic Beliefs:			
Simple	21.98	3.78	13-32
Certain	15.07	3.80	7-31
Quick	12.23	3.64	6-23
Omniscient Authority	14.72	2.80	5-25
Innate	21.39	4.78	10-34
Shipley Vocabulary	31.57	3.67	0-40
Letter Sets	21.35	4.13	0-30
RSpan	24.37	5.63	0-30
CRT	2.75	1.99	0-7
NFC	3.70	.70	1.08-5.87
Religious Measures			
Fundamental	-16.56	20.03	-40-40
Religious Practice	23.18	16.50	8-77
Quest			
Readiness	16.77	7.72	4-36
Self-Criticism	22.45	6.91	4-36
Openness	18.82	8.45	4-36
RWA	36.40	23.97	-80-41
Abductive Reasoning			
N Explanations	3.05	1.24	1.1-6
Total Quality	2.61	.87	0-4
N Explanations Wine	2.85	1.18	1-6
N Explanations MD	3.23	1.27	1-6

Total Quality Wine	2.51	.82	1-4
Total Quality MD	2.73	.90	0-4
Avg. Word Count Wine	538.22	373.14	34-347
Avg. Word Count MD	511.21	202.28	49.7-319.5
Reading Level Wine	10.52	1.60	4.6-12
Reading Level MD	9.32	1.94	5.8-12

Notes: Range represents minimum and maximum values for this sample. R Span= Score on reading span task; CRT= number of correct answers on cognitive reflection task; NFC= need for closure; RWA = right wing authoritarianism score; N explanations= number of initial explanations provided in AR task in both wine and MD scenarios; Total Quality= overall quality of reasoning in both wine and MD scenarios; N explanations Wine= number of explanations provided in the wine scenario; N explanations MD= number of explanations in the MD scenario; Total Quality wine= overall quality reasoning in Wine Scenario; total quality MD= overall quality of reasoning in the MD scenario; Avg. Word Count wine= total word count/ number of explanations in wine scenario; Avg. Word Count MD= total word count/number of explanations in MD scenario.

2.5 Hypotheses

Although the main question of interest is how epistemic beliefs, religiosity, and cognitive style affect abductive reasoning, it is important to consider the relationships that these different variables have to each other. Thus, it is predicted that:

1. The religious salience manipulation will have an effect on reported EB, NFC, and CRT. All of these effects, however, will depend on the initial level of religiosity (including quest and fundamentalism).
    a. The religious salience manipulation will increase endorsement of certain knowledge, simple knowledge, and gaining knowledge through omniscient authority.
    b. For religious individuals, NFC will increase after a religious salience manipulation.
    c. Those who identify as religious but not fundamentalist will show reduced reflectivity after a religious salience prime.

2. A disposition to be less reflective, as measured by the CRT, will be positively associated with religiosity as measured by the BIAC, religious quest, and religious fundamentalism. A disposition to be more reflective will be positively associated with religious disbelief/ quest. RWA, according to the RWA scale, will be positively related to religiosity- fundamentalism, quest, and religious practice.
3. Right wing authoritarianism, fundamentalism, quest, and BIAC will predict epistemic beliefs, especially simple knowledge, certain knowledge, and omniscient authority.

4. The disposition to be less reflective will be due to certain epistemic beliefs (certainty and authority of knowledge) as assessed by the EBI and evaluativist thinking measure. The disposition to be more reflective will be due to epistemic beliefs in knowledge being created and knowledge being integrated. Need for closure, as examined by the NFC scale, will predict cognitive reflection. Those with more of a need for closure will show more heuristic responses on the CRT.
5. Need for closure will be predicted by beliefs in simple knowledge and omniscient authority. Those high on both scales will be high on NFC.
6. Abductive reasoning will be predicted by Shipley vocabulary. Those high on need for closure will be more likely to reach a conclusion on the AR task, though not necessarily reason to the best solution, therefore need for closure will predict AR number of explanations and AR quality. Epistemic beliefs in certain knowledge and that knowledge is acquired through reasoning (those who score low on omniscient authority) will have higher quality AR explanations. Religious beliefs will not have a direct effect on abductive reasoning but will instead influence epistemic beliefs.

CHAPTER 3. RESULTS

3.1 Preliminary Factor Analysis of the EBI

The factorial structure of the EBI was first examined using an exploratory factor analysis which extracted six factors. One of the factors did not make theoretical sense so it was dropped and items were assigned to factors based on the loadings used by Schraw and colleagues (2002). This structure was examined by confirmatory factor analysis. The fit of the data to the five-factor model was mediocre as indicated by goodness of fit indices, X^2 (454) = 807.60, p = .00, RMSEA = .06, CFI = .69. See Table 4. The Cronbach's α for the innate (7 items), quick (5 items), certain (7 items), simple (8 items), and omniscient authority (5 items) subscales were .75, .50, .58, .42, and .46 respectively. With the exception of the innate subscale and, to a lesser extent, the certain knowledge scale, reliability of these subscales was moderate. The overall Cronbach's α (32 items; .68) was moderate.

Table 4

Factor loadings of epistemic belief inventory items on epistemic beliefs selected from Schraw, Bendixen, and Dunkle (2002) (N=244)

Item	Innate	Quick	Certain	Simple	Omniscient Authority
1. It bothers me when instructors don't tell students the answers to complicated problems.				.12	
2. Truth means different things to different people			**.51**		
3. Students who learn things quickly are the most successful.		**.37**			
4. People should always obey the law.					**.60**
5. Some people will never be smart no matter how hard they work.	**.64**				
6. Absolute moral truth does not exist.			**.60**		
7. Parents should teach their children all there is to know about life.					**.22**
8. Really smart students don't have to work as hard to do well in school.	**.50**				
9. If a person tries too hard to understand a problem, they will most likely end up being confused.				**-.48**	
10. Too many theories just complicate things.				**-.71**	
11. The best ideas are often the most simple.				**-.31**	
12. People can't do too much about how smart they are.	**.59**				
13. Instructors should focus on facts instead of theories.				**-.62**	

14. I like teachers who present several competing theories and let their students decide which is best.			.10		
15. How well you do in school depends on how smart you are.	**.43**				
16. If you don't learn something quickly, you won't ever learn it.		**.69**			
17. Some people just have a knack for learning and others don't.	**.53**				
18. Things are simpler than most professors would have you believe.				**-.39**	
19. If two people are arguing about something, at least one of them must be wrong.			**-.26**		
20. Children should be allowed to question their parents' authority.			**.41**		
21. If you haven't understood a chapter the first time through, going back over it won't help.		**.61**			
22. Science is easy to understand because it contains so many facts.		**.31**			
23. The moral rules I live by apply to everyone.			**-.52**		
24. The more you know about a topic, the more there is to know.				.13	
25. What is true today will be true tomorrow.			**-.45**		
26. Smart people are born that way.	**.77**				
27. When someone in authority tells me what to do, I usually do it.					**.54**
28. People who question authority are trouble makers.					**.35**
29. Working on a problem with no quick solution is a waste of time.		**.59**			

30. You can study something for years and still not really understand it.			.10
31. Sometimes there are no right answers to life's big problems.		**.51**	
32. Some people are born with special gifts and talents.	**.38**		

Note: Bold values denote significance at p<.01.

3.2 AR Task Scoring

The abductive reasoning measure was qualitatively coded by two trained raters. It is based on the number of explanations generated from the scenario, the quality of each explanation, the explanation self-ratings, adjustments made to initial explanations, the number of new explanations provided after additional evidence was presented, their use of new evidence, explanation quality after selecting the best explanation and their overall reasoning quality which assessed their performance on the task as a whole. The mean total quality scores for both the Wine and the MD scenarios is slightly higher than the means seen in previous studies. See Hertzog, Hale, and Krepps (2015) for a more thorough breakdown of the coding scheme. The raters had an inter-rater reliability score of .93. See Table 3. An average word count was calculated by taking the total word count and dividing it by the number of explanations.

3.3 Calculating Effectiveness of Priming Manipulation.

Participants were asked to identify their five most salient identities. These identities were then coded into larger categories including gender, religion, sexuality, ethnicity, family position (son, daughter, etc.), education, major, origin, hobbies, personality traits, and appearance. After the prime, 31 participants (13.5%) indicated religion/ faith as one of their top five salient identities. The proportion of people who identified religion as salient after a neutral prime (64.5%) was not significantly different from the proportion of participants who identified religion as salient after the religious prime (35.5%), $z = 1.58$, $p = .11$. (Benjamin, Choi Fischer, 2010). Another analysis was conducted with only participants who identified as Christian. Of Christians who were neutrally primed, 29.3% identified religion as a salient identity and 33.3% of them identified religion as salient after a religious prime $z = -.06$, $p = .95$. This difference was not significant. There was consequently no change in epistemic

beliefs, NFC, CRT or AR quality as a result of the prime. Because there was no effect of the priming manipulation, all results are collapsed across religiously primed and neutrally primed participants.

3.4 Correlations among Scales

To test the second hypothesis that CRT will be positively associated with religiosity, correlations were run. Religiosity (measured by fundamentalism, religious practice, and quest) was correlated with CRT scores. Fundamentalism correlated with CRT, and religious practice (BIAC). Quest was not correlated with CRT. Scores on the cognitive reflection task were not correlated with AR total quality performance or the number of explanations. These relationships indicated that fundamentalism and religious practice are negatively related to a reflective cognitive style, which is consistent with the hypothesis. Although CRT was not correlated with all religious variables as expected, right wing authoritarianism was correlated with fundamentalism, religious practice (BIAC), and the readiness and self-criticism sub-scales of the quest scale. Additionally, right wing authoritarianism was correlated with NFC, but not with CRT. This indicates that RWA is related to the religious variables and a measure of cognitive style. See Table 5 for the complete set of all correlations.

Table 5

Correlations of Epistemic Beliefs, Cognitive Ability, Cognitive Style, Religion and Abductive Reasoning Measures

	EBI-Simple	EBI-Certain	EBI-Quick	EBI-OA	EBI-Innate	Vocabulary	CRT	NFC	RSpan	Letter Sets
Christian	.09	**.31**	**-.17**	**.24**	-.04	.01	**-.15**	.02	-.05	-.03
Catholic	.09	.10	-.01	.09	-.03	.00	**-.17**	.09	-.06	.00
Hindu	-.04	-.01	.06	-.01	-.12	.01	.02	-.01	.01	-.08
Jewish	-.04	.08	**.15**	.00	.02	.04	.09	-.04	-.05	.05
Buddhist	.00	-.02	-.06	-.09	**-.17**	**-.20**	-.12	-.10	-.06	**-.17**
Muslim	-.04	.05	-.13	.02	-.12	-.03	-.03	.00	.04	-.12
No Religion	-.11	**-.35**	.13	**-.19**	**.20**	.01	**.31**	.00	.06	.11
Unaffiliated/ Other	.01	-.04	-.01	**-.14**	**.00**	.05	**-.13**	-.07	.09	.06
Fundamentalist	**.27**	**.47**	**-.14**	**.36**	-.08	-.11	**-.28**	.13	-.06	-.08
Religious Practice	.10	**.45**	**-.21**	**.34**	**-.15**	.05	**-.19**	.05	-.02	-.06
Quest: Readiness	.06	**.16**	-.06	.06	-.04	-.03	-.10	.00	**-.17**	-.10
Self-Criticism	**-.15**	**-.22**	.02	**-.15**	.00	**.14**	.06	**-.14**	-.03	-.01
Openness	.00	**-.14**	-.05	-.04	.02	.01	-.03	-.03	-.02	.09
RWA	**.38**	**.46**	.12	**.40**	.03	-.07	-.01	**.29**	-.03	-.03
N Explanations	.10	.03	-.02	.11	.10	.02	-.08	.12	.02	.10
New Evidence	-.02	.09	.06	.03	.12	**.20**	**.16**	**.15**	.13	**.20**
Pick the Best	-.02	.01	.04	-.01	.04	**.17**	.07	.06	.02	**.19**
Total Quality	.06	.07	.06	.03	.11	**.25**	.11	.09	.02	**.17**
Average WC	.03	.00	.07	-.09	-.02	**.16**	.12	-.01	.09	.12
Reading Level	-.11	.01	-.08	-.09	-.08	**.25**	.04	-.08	.06	.11

Note: Bold values denote significance at $p<.05$; EBI- Simple= epistemic belief inventory, simple knowledge dimension; EBI Certain= epistemic belief inventory, certain knowledge dimension; EBI- Quick= epistemic belief inventory quick knowledge dimension; EBI- OA= epistemic belief inventory, omniscient authority dimension; EBI- innate= epistemic belief inventory , knowledge is innate dimension; Vocabulary= Shipley vocabulary score; R Span= reading span task; RWA= right wing authoritarianism; N Explanations= number of explanations initially provided in both AR and Wine scenarios; New Evidence= ability to incorporate new evidence into existing explanations or propose new explanations; Pick the best= quality of reasoning toward the best answer and justifying choice; Total Quality= total quality of abductive reasoning in both AR and wine scenarios; Average WC= average word count, total number of words/ number of explanations; Reading Level= average Flesch-Kincaid score for explanations

3.5 Regression Analyses.

3.5.1 Prediction Equations for Epistemic Beliefs

The third hypothesis proposes that RWA, fundamentalism, quest, and BIAC will predict epistemic belief. Right wing authoritarianism, fundamentalism, quest readiness, quest self-criticism, quest openness and religious practice were regressed on simple, certain, quick, omniscient authority, and innate epistemic beliefs. These religious variables significantly predicted simple knowledge ($F(6,211)=6.34$, $p=.00$, $R^2=.16$), certain knowledge ($F(6,211)=15.71$, $p=.00$, $R^2=.32$), quick knowledge ($F(6,212)=5.55$, $p=.00$, $R^2=13.9$), and omniscient authority ($F(6,212)=8.63$, $p=.00$, $r^2=.20$). They do not significantly predict innate knowledge, ($F(6,212)=1.08$, $p=.38$, $R^2=.03$). See Table 6. This supports the hypothesis that religious teachings and practice can account for some variance in epistemic beliefs, except for a belief in innate knowledge.

Table 6

Religious Predictors of Epistemic Beliefs

	Simple β	Certain β	Quick β	Omniscient Authority β	Innate β
RWA	**.35**	**.22**	**.40**	**.28**	.12
Fundamentalism	.16	.07	-.11	.09	.03
Quest:					
Readiness	.05	**.17**	.05	-.05	.01
Self-Criticism	-.09	-.11	.14	-.08	.02

Openness	.04	**-.21**	-.09	.01	.04
Religious Practice	**-.22**	**.25**	**-.30**	.13	-.21

Note: Bold values denote significance at p<.05; RWA= Right wing authoritarianism

3.5.2 Prediction Equations for CRT.

The fourth hypothesis posits that reflectivity will be due to epistemic beliefs in certain knowledge and knowledge from authority. In a regression analysis, gender, β=.27, p=.00 and race (black), β=-2.89, p=.00 predicted CRT. None of the epistemic belief measures significantly predicted CRT beyond gender and race. This indicates that epistemic beliefs do not account for variance in reflective style thus the forth hypothesis is not supported.

3.5.3 Prediction Equation of NFC

The fifth hypothesis was that epistemic beliefs in simple knowledge and omniscient authority will predict NFC. A regression analysis revealed beliefs in simple knowledge, β=.18, p=.00, omniscient authority, β=.31, p=.00, and innate knowledge, β=.26, p=.00 were significant predictors of NFC along with Shipley Vocabulary scores, β=-.20, p=.00, together these variables accounted for 30% of the variance in NFC, F (6,212) =15.03, p=.00. CRT was not a significant predictor of NFC controlling on other variables. Unlike CRT, epistemic beliefs do account for variance in need for closure.

3.5.4 Prediction Equation for AR Number of Explanations

None of the variables significantly predicted the number of explanations. In the first model, with gender, race, and no religion as predictors, conservativism was a significant predictor. However, the effect dropped out when more variables were added to the model. Innate knowledge was also approaching significance in the second model but lost significance as more predictors were added. The final model, which included demographic variables (gender, race, political affiliation- conservative, religion- no religion), epistemic beliefs, cognitive style and religious variables, accounted for 6% of the variance in number of explanations, but was not significant, $F(12, 203)=1.05$, $p=.40$. See Table 7.

Table 7

Predictors of AR Number of Explanations

Model		β	Standard Error	Standardized β	t	R^2
1	Constant	**3.01**	.16		18.31	.00
	Gender	.01	.19	.01	.08	
	White	.13	.19	.05	.68	
2	Constant	**2.30**	1.11		2.07	**.23**
	Gender	.15	.18	.06	.84	
	White	.18	.17	.07	1.04	
	Vocabulary	.04	.03	.11	1.60	
	Letter Sets	.023	.02	.08	1.19	
	CRT	-.08	.05	-.12	-1.58	
	NFC	.20	.12	.11	1.65	
	Avg. Word Count	**-.01**	.00	-.38	-4.80	
	Reading Level	-.08	.05	-.11	-1.43	
	R Span	.01	.01	.07	.98	
3	Constant	1.91	1.14		1.68	**.27**
	Gender	.13	.18	.05	.70	
	White	.13	.18	.05	.71	
	Vocabulary	.05	.03	.13	1.79	
	Letter Sets	.03	.02	.08	1.16	
	CRT	-.06	.05	-.09	-1.13	
	NFC	.18	.13	.10	1.39	
	Avg. Word Count	**-.01**	.00	-.37	-4.61	
	Reading Level	-.08	.05	-.12	-1.47	
	R Span	.01	.01	.07	.98	
	Conservative	.34	.28	.09	1.18	
	RWA	.00	.01	.01	.07	
	Fundamentalism	.00	.01	.05	.41	
	Religious Practice	.00	.01	.01	.10	
	Quest:					
	Readiness	.01	.01	.03	.34	
	Self-Criticism	-.01	.02	-.06	-.75	

	Openness	.02	.01	.15	1.73	
4	Constant	1.37	1.40		.98	**.30**
	Gender	.13	.19	.05	.71	
	White	.12	.18	.05	.64	
	Vocabulary	.05	.03	.12	1.58	
	Letter Sets	.03	.02	.09	1.24	
	CRT	-.06	.05	-.10	-1.29	
	NFC	.13	.14	.07	.88	
	Avg. Word Count	**-.01**	.00	-.39	-4.85	
	Reading Level	-.06	.05	-.09	-1.18	
	R Span	.01	.01	.07	.97	
	Conservative	.30	.29	.08	.99	
	RWA	.00	.01	.01	.11	
	Fundamentalism	.00	.01	.04	.31	
	Religious Practice	.01	.01	.08	.67	
	Quest:					
	Readiness	.01	.01	.04	.47	
	Self-Criticism	-.01	.02	-.07	-.84	
	Openness	.02	.01	.12	1.39	
	EBI:					
	Simple	.02	.03	.07	.93	
	Certain	-.03	.03	-.08	-.88	
	Quick	.00	.03	.01	.13	
	OA	-.02	.04	-.05	-.56	
	Innate	**.04**	.02	.14	1.95	

Note: Bold values denote significance at $p<.05$; Vocabulary= Shipley Vocabulary Score; Avg. CRT= Cognitive Reflection Test; NFC= Need for Closure; Word count= number of words in AR explanations/ number of explanations; Reading Level= Flesch-Kincaid score of answers in AR task; R Span= reading span; RWA= right wing authoritarianism; OA= epistemic belief inventory, omniscient authority dimension

3.5.5 Prediction Equation for AR Total Quality

To see if anything beyond demographic and known cognitive factors predict abductive reasoning, a hierarchical regression with AR quality as a predictor was run. Epistemic beliefs, NFC, CRT, religiosity, and fluid intelligence were not significant predictors of AR quality. Shipley vocabulary was a significant predictor in some of the models but not in the final model. Need for closure was a significant predictor in two of the models but the significance dropped out in the final model. Race and average word count were the only significant predictors of AR quality in the final model. Therefore, the sixth hypothesis that Shipley reasoning, certain knowledge, and omniscient authority will predict abductive reasoning is not supported.

To test the final hypothesis that need for closure will predict choosing an answer but not the best answer, a regression with NFC as a predictor of picking the best explanation was conducted. Need for closure was not a significant predictor of PTB scores, β=.08,p=.38. The pick the best score indicates that participants chose an explanation and gave reasons for choosing that explanation. Need for closure scores did not predict that a participant chose an explanation. As noted before, though, NFC was a significant predictor of AR quality. Therefore this hypothesis is partially supported, NFC does not predict choosing the best answer but it does predict overall quality. See Table 8.

Table 8

Predictors of AR Total Quality

Model		β	Standard Error	Standardized β	t	R^2
1	Constant	**2.42**	.11		21.61	**.06**
	Gender	.00	.13	.00	.03	
	White	**.42**	.13	.24	3.30	
2	Constant	-.45	.75		-.60	**.28**
	Gender	-.08	.12	-.05	-.71	
	White	**.34**	.12	.19	2.97	
	Vocabulary	**.04**	.02	.13	1.97	
	Letter Sets	.01	.02	.03	.38	
	CRT	.01	.03	.02	.22	
	NFC	**.20**	.08	.16	2.39	
	Avg. Word Count	**.01**	.00	.41	5.40	
	Reading Level	.00	.04	.01	.11	
	R Span	-.01	.01	-.06	-.85	
3	Constant	-.47	.77		-.61	**.31**
	Gender	-.08	.12	-.05	-.68	
	White	**.35**	.12	.20	2.90	
	Vocabulary	**.04**	.02	.14	2.01	
	Letter Sets	.01	.02	.04	.60	
	CRT	.02	.03	.04	.54	
	NFC	**.19**	.09	.15	2.16	
	Avg. Word Count	**.01**	.00	.41	5.24	
	Reading Level	.00	.04	.01	.09	
	R Span	-.01	.01	-.044	-.67	
	Conservative	-.18	.19	-.07	-.93	
	RWA	.00	.00	.03	.28	
	Fundamentalism	.00	.01	.09	.67	
	Religious Practice	.00	.01	.01	.06	
	Quest: Readiness	.01	.01	.09	1.08	

	Self-Criticism	-.01	.01	-.05	-.63	
	Openness	-.00	.01	-.02	-.18	
4	Constant	-.72	.96		-.75	**.31**
	Gender	-.08	.13	-.05	-.61	
	White	**.35**	.13	.20	2.79	
	Vocabulary	.04	.02	.14	1.78	
	Letter Sets	.01	.02	.05	.64	
	CRT	.01	.03	.04	.49	
	NFC	.16	.10	.13	1.64	
	Avg. Word Count	**.01**	.00	.40	4.98	
	Reading Level	.01	.04	.02	.19	
	R Span	-.01	.01	-.04	-.64	
	Conservative	-.20	.20	-.08	-.99	
	RWA	.00	.00	.02	.20	
	Fundamentalism	.00	.01	.08	.57	
	Religious Practice	.00	.01	.03	.23	
	Quest:					
	Readiness	.01	.01	.09	1.09	
	Self-Criticism	-.01	.01	-.05	-.62	
	Openness	.00	.01	-.02	-.25	
	EBI:					
	Simple	.01	.02	.03	.41	
	Certain	.00	.02	-.02	-.19	
	Quick	.00	.02	.00	-.01	
	OA	.00	.02	.01	.11	
	Innate	.01	.01	.05	.66	

Note: Bold values denote significance at $p<.05$; Vocabulary= Shipley Vocabulary Score; Avg. CRT= Cognitive Reflection Test; NFC= Need for Closure; Word count= number of words in AR explanations/ number of explanations; Reading Level= Flesch-Kincaid score of answers in AR task; R Span= reading span; RWA= right wing authoritarianism; OA= epistemic belief inventory, omniscient authority dimension

CHAPTER 4. DISCUSSION

The main goal of the present study was to understand why those high on cognitive ability do not always reason at a high level. By and large, people assess evidence in biased patterns that reinforce their positions or the positions of others who hold the same ideology (Kahan, 2013). Where do biases come in, is it an underlying general belief system such as personal epistemology or religion? Or is it more due to a cognitive style that makes one foreclosed in his or her thinking? It is assumed that there is a complex interaction between these variables, and other untested variables, that ultimately drives reasoning. The present study examined religiosity, cognitive style, and epistemic beliefs to see how they affect performance on an abductive reasoning task.

A religious prime was also used as an attempt to shift people into a more foreclosed thought pattern to more clearly illustrate the constraints of belief on reasoning. Though other studies (Benjamin, Choi & Fischer, 2010; Sagioglou & Forstmann,2013) have found success with implicit religious primes, it does not appear that the religious prime primed the participants. In fact, a higher proportion of people in the neutral condition identified faith or religion as a salient identity compared to the religious prime condition. This opposite effect of the prime could be because students were sensitized to the role of religion in the study. At the time of the prime, which was the first measure in the second session, participants had already

answered questions about their and their parents' religious and political beliefs and completed the RWA assessment in the first section. These proportions are not significantly different, however. Additionally, there is no evidence that the prime shifted EBI, NFC, or CRT for any participants as predicted in the first hypothesis.

The second hypothesis predicted that low levels of cognitive reflection would be correlated with high levels of religiosity. As hypothesized, religiosity (fundamentalism and religious practice) was negatively correlated with cognitive reflection that is indicative of a less reflective cognitive style for those high on religiosity. Although prior studies (Gervais & Norenzayan, 2012; Shenhav et al., 2012) have examined the role of increasing analytic processing and seeing how this affects religious beliefs, this study attempted to manipulate religiosity to see how salient religious beliefs affect analytic processing. Shenhav and colleagues (2012) propose that belief in God may play a supporting role in developing an intuitive belief-formation process. Believing in God yields accessible explanations and has a heuristic quality. Belief in God may additionally cause a feedback cycle where satisfactory explanatory appeals to God reinforce the intuitive cognitive style that originally led to God beliefs (Shenhav et al., 2012). The results from the present study suggest that although believing in God can lead a person to manifest a more heuristic reasoning style on the CRT, making beliefs about God salient through a social priming manipulation did not increase intuitive responding on the CRT. Another portion of the second hypothesis stated that more reflectivity would lead to higher scores on the three dimensions of the quest scale. This part of the hypothesis was not supported. There was no relationship between the CRT and of the dimensions of the quest scale

and reflectivity. However, given that the prime did not seem to actually increase religious salience, these conclusions are tentative.

The last part of the second hypothesis suggested that RWA would be related to religiosity. As expected, right wing authoritarianism was highly correlated with fundamentalism suggesting that these variables are assessing a similar dimension of submission to authority and adhering to prescribed conventions. Religious practice was also moderately correlated with RWA perhaps because engaging in religious practice is an important convention in religious individuals. The readiness aspect of quest could fit with fundamentalism because it does not involve the questioning of a religious doctrine but instead whether a person has the desire to ask questions about the meaning of life and their relation to the world. The self- criticism and perception of religious doubt subscale should be and is negatively related to right wing authoritarianism because this dimension of the subscale scores participants who question religious doctrine higher than those who accept religious doctrine without question. The acceptance of a doctrine fits in more with right wing authoritarians.

The third hypothesis looked into what predicts epistemic beliefs. I proposed that RWA, fundamentalism, quest, and BIAC would predict epistemic beliefs, specifically beliefs in simple knowledge, certain knowledge, and omniscient authority. Right wing authoritarianism predicted the epistemic beliefs of simple knowledge, certain knowledge and omniscient authority. This could be because authoritarian people emphasize following a certain doctrine dictated by authority and would therefore be more likely to endorse knowledge that comes from certain

and authoritative sources. Religious practice also predicted epistemic beliefs in certain, simple, and quick knowledge along with omniscient authority. This is consistent with the idea that religious beliefs can teach ideas about certainty and truth that extend beyond the religious doctrine and inform how people approach knowledge in general. Overall, this hypothesis was supported.

None of the epistemic belief measures significantly predicted CRT which means that the fourth hypothesis about epistemic beliefs affecting reflectivity does not hold. These results imply that epistemic beliefs do not directly impact a heuristic or analytic thinking style. Culture has been found to play a role in transmitting intuitive cognitive style; it is very possible that underlying belief systems other than the epistemic and religious beliefs measured in the current study feed into reflective cognitive style (Schommer- Aikins & Easter, 2014). Along those lines, NFC did not predict CRT which implies that an increased desire for closure does not necessarily lead to a heuristic mode of numerical reasoning. Again, this does not support the hypothesis. Gender and race were the only significant predictors of CRT. This is likely because the CRT is a numerical test and numeracy differs between gender and different racial groups (Campitelli & Gerrans, 2003; Liberali et al., 2012).

The fifth hypothesis predicted that simple knowledge and omniscient authority would predict NFC. The present study found that specifically simple knowledge, omniscient authority, and innate knowledge (along with the Shipley Vocabulary) predicted NFC. Believing that knowledge is simple may lead to person to seek closure to a problem early on. Likewise, believing that knowledge comes from

authority may decrease knowledge seeking behaviors after knowledge is gained from the authority figure. People with this perspective often see knowledge as absolute and find ambiguity or disagreement to be a challenge to the black and white nature of knowledge (Love & Guthrie, 1999). Finally, though it was not originally believed to predict NFC, innate knowledge may increase a desire for closure because someone who does not believe that everyone can reach the same level of knowledge as an expert may seek to find a suitable solution without considering all parts of a situation because he or she does not think that getting to an expert level is possible. Research on fixed and incremental theories of intelligence has demonstrated that when a task is difficult, those with a fixed theory perseverate on the same strategy, which could indicate that they closed early on a certain strategy (Dweck & Leggett, 1988).

The last hypothesis first stated that Shipley vocabulary would predict abductive reasoning. As in the previous validation studies for the AR task, Shipley reasoning predicted AR quality. Need for closure has not been previously linked to AR performance and the present study shows that having a strong desire to close on a problem does not influence the number of explanations or the quality of the explanation that is chosen, but it does predict the total quality of reasoning, at least in the present AR task. The cognitive style of wanting closure then, does predict higher reasoning quality. The total quality score takes the quality of explanations, the synthesis of old and new evidence, and the justification for choosing a certain answer into account. Those high on need for closure may provide higher quality explanations because they value the permanence and plausibility of an answer more than they feel an urgency to close on any answer. The same type of thinking could also lead

participants to reason at a higher level in choosing a final explanation. High scores in either or both of these domains contribute to higher quality scores. In addition to NFC, Shipley vocabulary and race also predicted abductive reasoning. Crystallized intelligence was implicated in AR in previous validation studies for the AR task (Hertzog, Hale, & Krepps, 2015; Abductive Reasoning Validation Study 2. Unpublished Data). Likewise, verbal ability is a strong predictor of critical thinking performance (Clifford, Boufal, & Kurtz, 2004). The racial component may be due to the types of critical thinking that white students are more likely to receive than students of another race.

It was also presumed that epistemic beliefs in certain knowledge and low omniscient authority would predict AR quality. Epistemic beliefs do not predict the overall quality of abductive reasoning. The scoring method may have been the reason and perhaps a more careful content analysis of the responses would reveal a contribution of epistemic beliefs. Epistemic beliefs did not predict abductive reasoning. These "limitations of the knower" do not actually seem to be showing distinguishable effects on reasoning ability. One possible reason for this is that epistemic beliefs are related to a disposition to avoid argument (Nussbaum & Bendixen, 2003). Students with less developed epistemic beliefs may experience uncertainty about their epistemic beliefs or epistemic doubt, which can challenge a stable world view. They may experience discomfort about engaging in the reasoning task and may not engage to their fullest ability. If this were the case, though, we would expect to see poorer reasoning in those with less sophisticated beliefs. Instead, we just see no effect of epistemic beliefs on abductive reasoning. Epistemic beliefs have

been shown to play a role in critical thinking, Chan and colleagues (2011) found that beliefs in certain knowledge impacted participant's ability to address counterarguments in an argument task. Certain knowledge also led to lower scores on a critical thinking assessment (Chan et al., 2011). It could be that this specific test of abductive reasoning may not be influenced by factors like religious or epistemic beliefs.

Another possible reason that epistemic beliefs did not influence abductive reasoning scores might be due to the actual measure of epistemic beliefs used. Other studies that have used the Epistemic Belief Inventory (Chan et al., 2011; Nussbaum & Bendixen, 2003) acknowledge that the quick learning and omniscient authority factors do not emerge with this scale. The present study was able to find a quick learning factor; however, the omniscient authority variable did not emerge as strongly as hoped. Because the authority dimension of epistemic beliefs was predicted to be one of the larger predictors of foreclosed thinking, it is possible that a better measure of this dimension would then reveal the influence of epistemic beliefs on abductive reasoning.

I also predicted that religiosity would not have a direct effect on abductive reasoning but would instead influence abductive reasoning via epistemic beliefs. This hypothesis was partially supported in that there was not a direct effect of religion on abductive reasoning quality. Because epistemic beliefs did not predict abductive reasoning quality, religious beliefs are likely not changing abductive reasoning quality via epistemic beliefs. Religiosity has not been shown to predict reasoning

about secular problems (Hunsberger et al, 1996) so it is possible that religion does not have much bearing when reasoning about issue without a religious quality. Overall, the individual difference measures did not predict abductive reasoning quality beyond demographic and cognitive ability measures.

On the whole, religiosity and epistemic beliefs did not predict abductive reasoning. Need for closure, a cognitive style does predict AR quality. This outcome suggests that the type of critical thinking about scientific evidence measured by the AR task is not compromised by beliefs. This could suggest a robustness of the measure but could also imply that these "limitations of the knower" are not actually limiting the ability to reason. In the case of need for closure, depending on if people value permanence of a solution over urgency, it may even enhance reasoning. People may not be as susceptible to cognitive bias as has previously been thought. However, these results were found in a population of students at a technical university that emphasizes scientific thinking. It is possible that in a more general population, one that is not selected from a school of engineering where people study the scientific process, there may be a relationship. In a sample of more religious people, perhaps from a religious university, a relationship between religiosity, epistemic beliefs and abductive reasoning may potentially be manifest and a more foreclosed style would account for some variance in AR performance.

Given that the beliefs variables relate to each other in predictable ways, this outcome is not just a result of low reliability and validity in the beliefs measures. As expected, religious beliefs and practice predict epistemic beliefs that predict need for

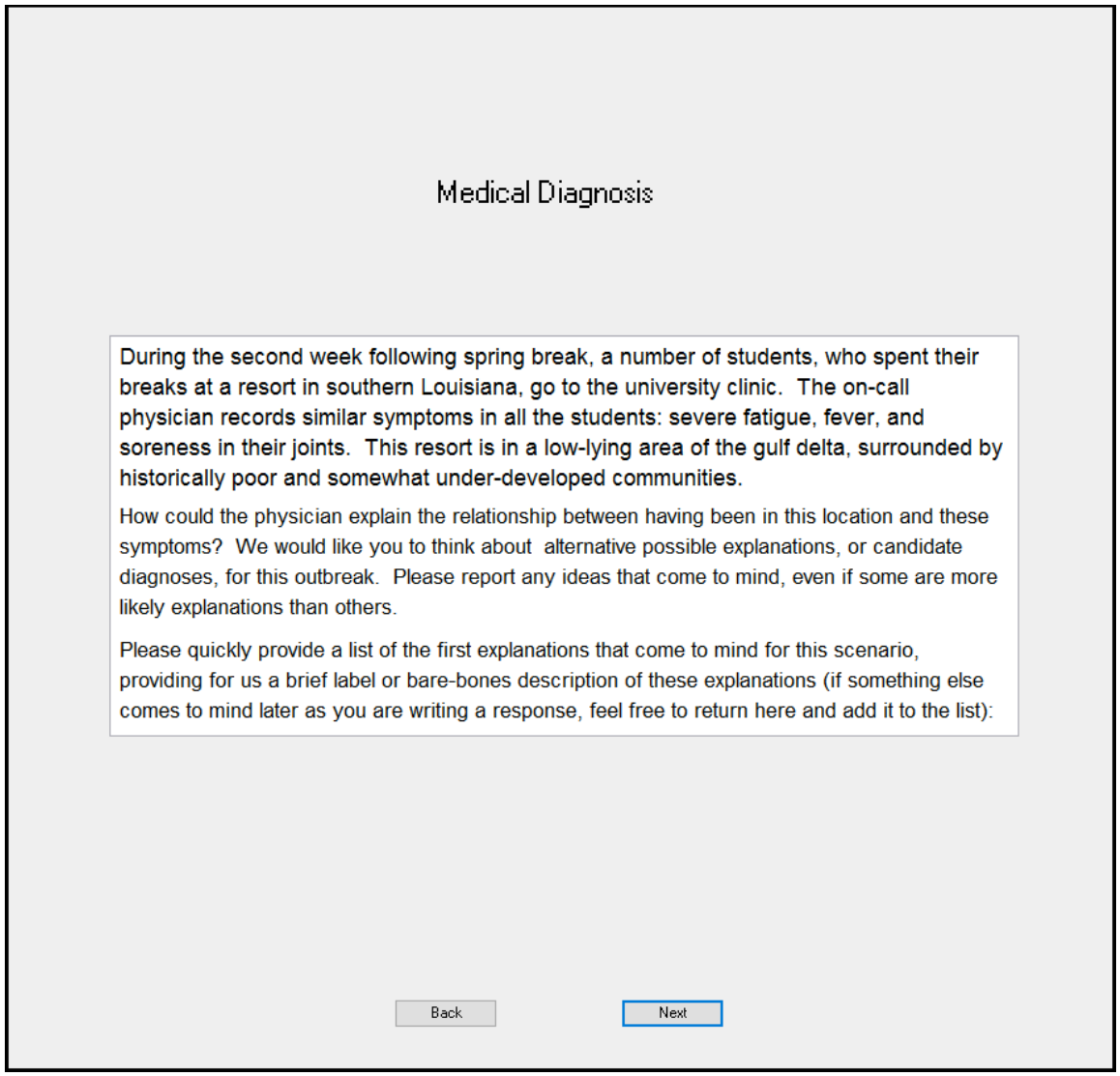
closure. Religious and epistemic beliefs, then, are involved in a certain thought patterns. Although these thought patterns are consistent, these patterns of thinking do not seem to affect abductive reasoning ability or limit a person's ability to reason abductively.

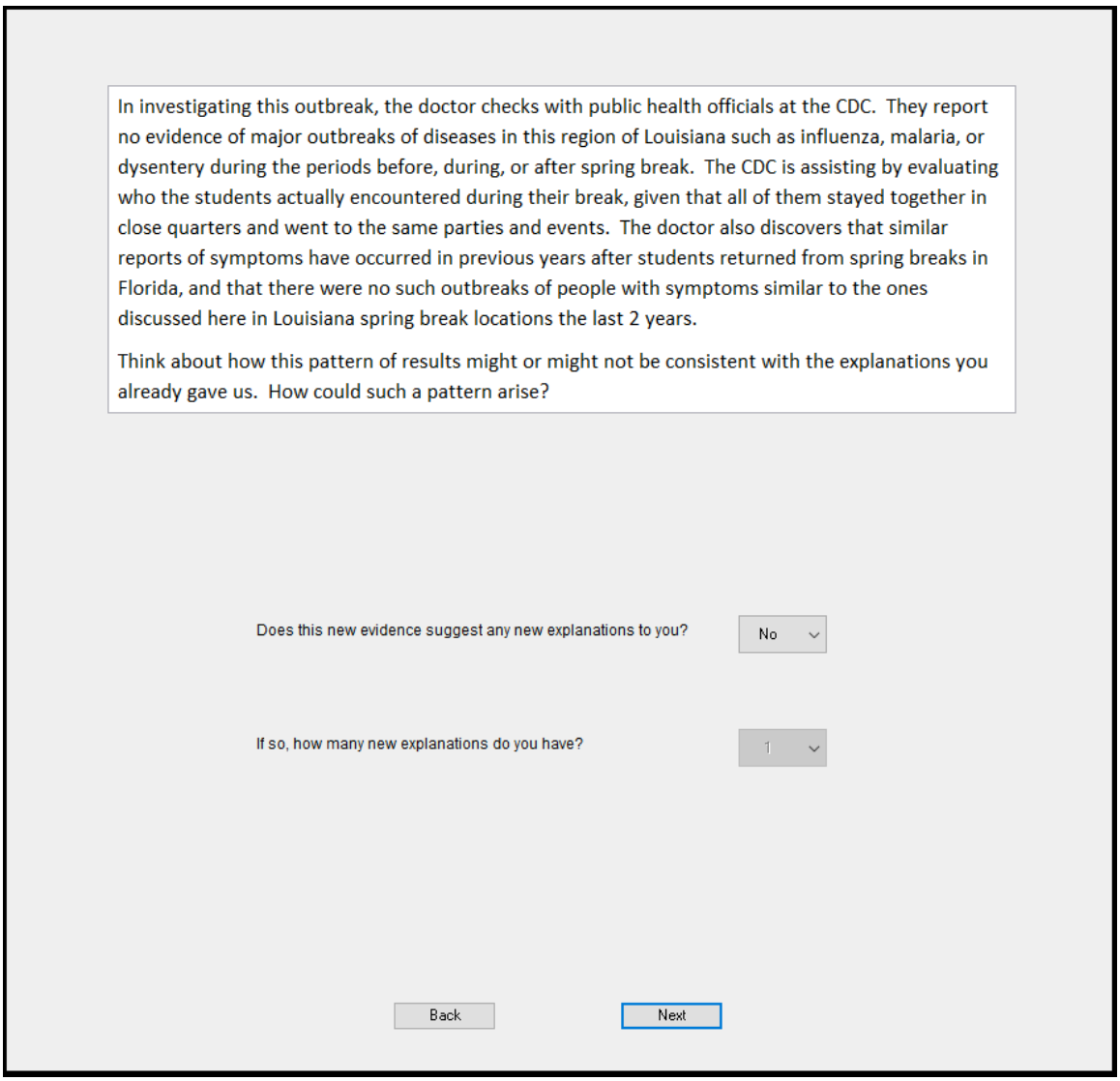
Halpern (2014) has proposed that dispositions, individual background variables, and situational variables affect the way a situation is interpreted and if it requires critical thinking. The present study tested various individual background variables and demonstrated that a person's beliefs about knowledge, cognitive style, and religion do not affect performance on the abductive reasoning task. It is possible that these variables do not lead participants to see the task as one of critical thinking and therefore the participants do not engage in critical thinking. Another possibility is that the participants lack the skills to critically think (Halpern, 2014). Even if participants do have the skills, they may have a deficiency in metacognitive monitoring and use an ineffective skill without realizing it (Halpern, 2014). The breakdown in the ability to effectively reason has potential to occur in several parts of the process. More work is needed to determine exactly where this breakdown occurs.

APPENDIX A

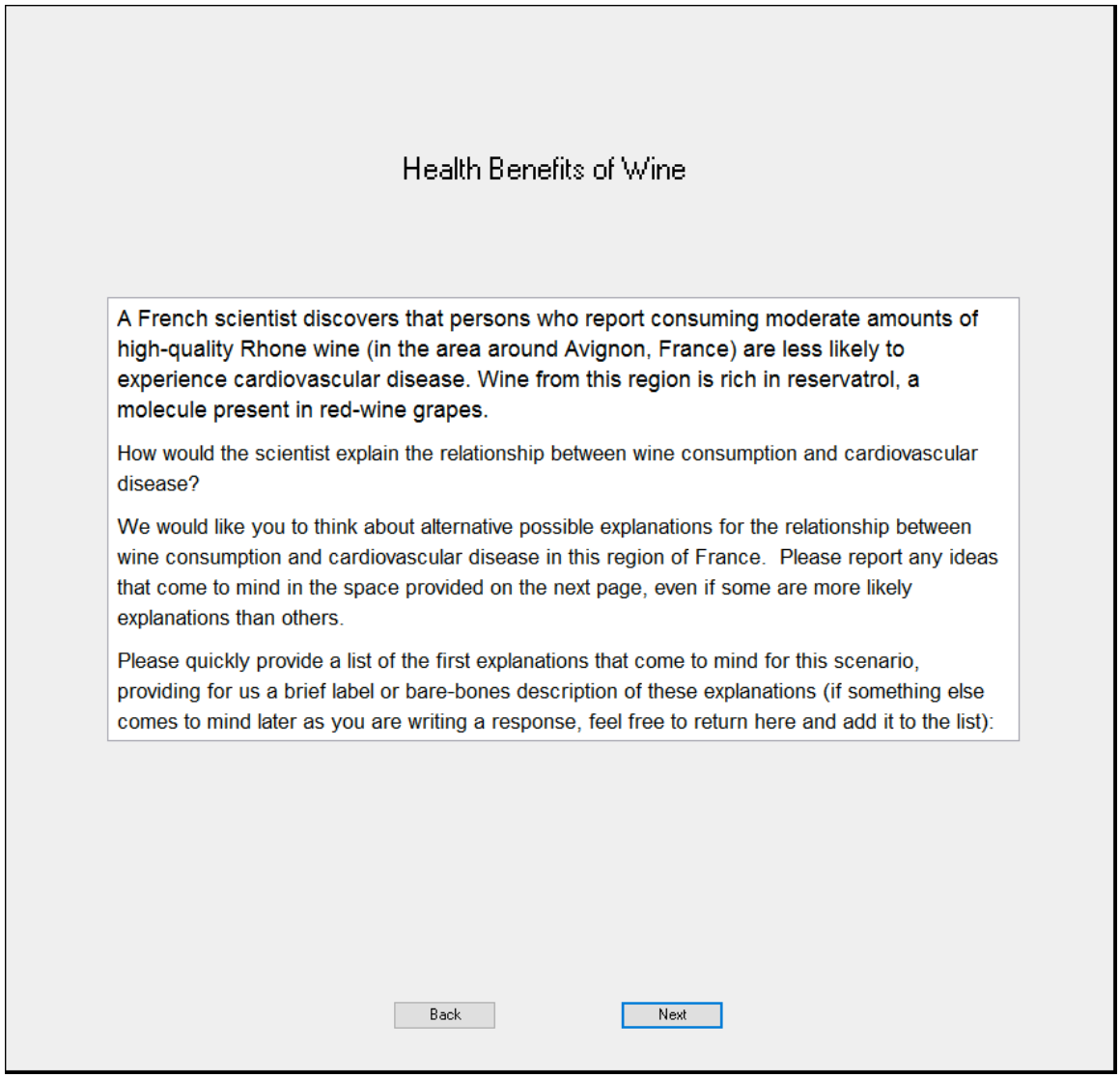
Abductive Reasoning Task initial evidence and additional evidence.

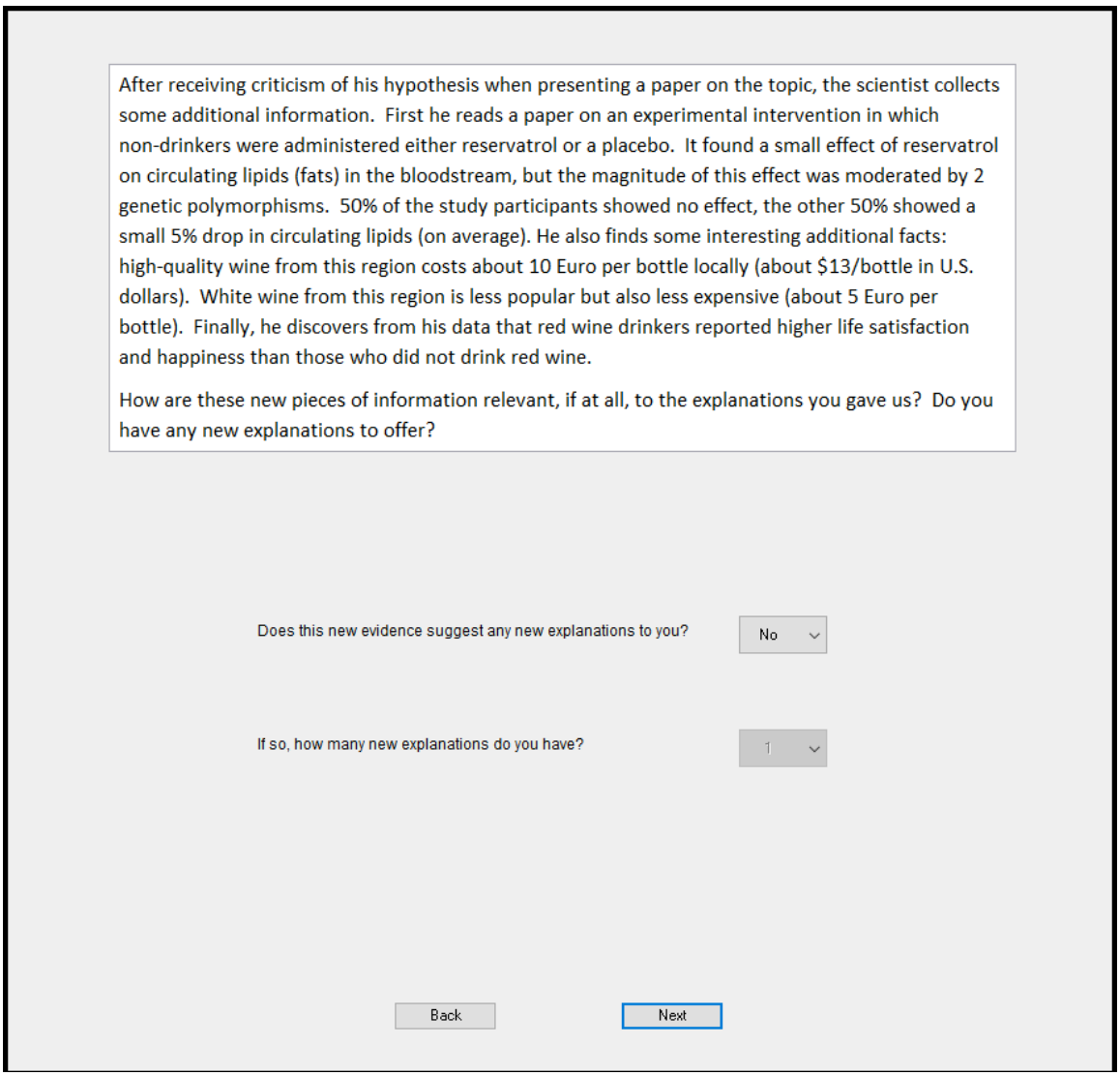
MD




In investigating this outbreak, the doctor checks with public health officials at the CDC. They report no evidence of major outbreaks of diseases in this region of Louisiana such as influenza, malaria, or dysentery during the periods before, during, or after spring break. The CDC is assisting by evaluating who the students actually encountered during their break, given that all of them stayed together in close quarters and went to the same parties and events. The doctor also discovers that similar reports of symptoms have occurred in previous years after students returned from spring breaks in Florida, and that there were no such outbreaks of people with symptoms similar to the ones discussed here in Louisiana spring break locations the last 2 years.
Think about how this pattern of results might or might not be consistent with the explanations you already gave us. How could such a pattern arise?
Does this new evidence suggest any new explanations to you?
No
If so, how many new explanations do you have?
1
Back
Next

Wine


Health Benefits of Wine
A French scientist discovers that persons who report consuming moderate amounts of high-quality Rhone wine (in the area around Avignon, France) are less likely to experience cardiovascular disease. Wine from this region is rich in reservatrol, a molecule present in red-wine grapes.
How would the scientist explain the relationship between wine consumption and cardiovascular disease?
We would like you to think about alternative possible explanations for the relationship between wine consumption and cardiovascular disease in this region of France. Please report any ideas that come to mind in the space provided on the next page, even if some are more likely explanations than others.
Please quickly provide a list of the first explanations that come to mind for this scenario, providing for us a brief label or bare-bones description of these explanations (if something else comes to mind later as you are writing a response, feel free to return here and add it to the list):
Back
Next


After receiving criticism of his hypothesis when presenting a paper on the topic, the scientist collects some additional information. First he reads a paper on an experimental intervention in which non-drinkers were administered either reservatrol or a placebo. It found a small effect of reservatrol on circulating lipids (fats) in the bloodstream, but the magnitude of this effect was moderated by 2 genetic polymorphisms. 50% of the study participants showed no effect, the other 50% showed a small 5% drop in circulating lipids (on average). He also finds some interesting additional facts: high-quality wine from this region costs about 10 Euro per bottle locally (about $13/bottle in U.S. dollars). White wine from this region is less popular but also less expensive (about 5 Euro per bottle). Finally, he discovers from his data that red wine drinkers reported higher life satisfaction and happiness than those who did not drink red wine.
How are these new pieces of information relevant, if at all, to the explanations you gave us? Do you have any new explanations to offer?
Does this new evidence suggest any new explanations to you?
No
If so, how many new explanations do you have?
1
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APPENDIX B

Priming Sentences

Religious

She felt the spirit.

The dessert was divine.

Her presence was appreciated.

Do it once more.

I mailed it over.

Give thanks to God.

Yesterday he finished it.

The book was sacred.

Prophets reveal the future.

I was somewhat prepared.

Neutral

She was always worried.

Replace the old shoes.

Have a good day.

Do it once more.

I mailed it over.

He saw the train.

Yesterday he finished it.

The sky is blue.

I bought it today.

I was somewhat prepared

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